

Etymotic Research ER-4S Earphones

H P R
LISTENING
TEST

By Bruce Bartlett with Jenny Bartlett

Revealing sound right into your ear canal

These are the finest earphones or headphones I've ever heard. Costing only \$329, the ER-4S earphones compete with electrostatic headphones selling for \$1000 or more.

The ER-4S Canal Phone by Etymotic Research is a set of dynamic earphones which you insert in your ear canals. This placement provides an air-tight seal which keeps out noise and allows superb deep bass.

Design

The earphones in their carrying pouch fit in your shirt pocket. You might say, "Is that all there is for \$300?" But give them a listen; they sound BIG! These tiny units deliver refer-

ence-quality sound that is astonishing.

One reason for this quality is that the Canal Phone's design is based on extensive research into human hearing. To sound natural, earphones and headphones should not have a flat response (as measured at the eardrum). Instead, they need a big emphasis in the upper midrange — a broad 14 dB peak at 3 kHz.

Why is this? When we are listening in a reverberant room, sound approaches us randomly from all directions. That is, we hear a diffuse soundfield. The head, outer ears and ear canals affect the incoming sound by adding a big peak at around 3 kHz. Since earphones bypass

the head and outer ears, this 3 kHz peak is missing. It therefore needs to be restored by tailoring the response of the earphones.

Etymotic claims that its earphones have the most accurate match to the ear's diffuse-field response. Another model, ER-4B, closely matches the diffuse curve. It's meant for listening to binaural recordings made with a dummy head placed in the audience area. Model ER-4S, however, has slightly reduced highs, and it sounds more natural when listening to the usual close-miked recordings of classical and popular music. The ER-4S sounds best with most recordings.

Each black plastic earphone is the size of a cigarette filter. A red flex relief denotes the right channel; blue denotes left. The 'phones have a thin four-foot cable, gold-plated mini earphone plug and gold-plated 1/4" 'phone plug adapter. Two types of ear seal are provided: compressible foam or triple flanges made of soft silicone rubber. Extra ear seals are included. If your ear canals are unusual in size or shape, the tips might be uncomfortable or have a poor seal. For best fit, you can order custom-fitted ear

molds from the company. A shirt clip and a foam-lined case complete the package.

Since ear wax can clog the filters built into the earphone tips, Etymotic suggests that you clean your ears before use. (I put cotton swabs in the carrying case for this purpose.) If the filters get clogged, you can replace them with the spare filters provided. The inner end of each ear seal is about 1/4" from your eardrum when fully inserted.

Etymotic rates the frequency response as 20 Hz to 16 kHz. Sensitivity is 98 dB SPL per mW, while maximum output is 114 dB SPL. Impedance is rated at 100 ohms. The 'phones weigh only 1 ounce. As for polarity, + voltage makes + acoustic pressure.

Comfort

To me, the Canal Phones are more comfortable than most headphones because there is no pressure on the outer ears. Some users, however, might not like the sealed-off effect. It's like wearing earplugs. In fact, the isolation from outside sounds is excellent (24 dB or more). When you wear the Canal Phones, you're in a musical world of your own. They're great for listening in noisy environments or for monitoring a recording when you are in the same room as the musical ensemble.

According to Etymotic Research, quiet musical sounds on recordings are masked by the ambient noise level in homes (typically 43 dBA). This noise prevents you from hearing the softest sounds unless you turn up the volume to unnatural levels. But when you wear the Canal Phones, you can hear the full dynamic range without excessive volume.

When I first listened to the ER-4S with the soft-flange ear seal, I was disappointed by the

weak bass and sizzly highs. The company cautions that if the earphone is not tightly sealed to the ear canal, the bass response will be reduced. I switched to the ear seals made of foam, which accommodate larger ear canals and conform better to their shape. I rolled them tightly between my fingers, put them in my ears, and let the foam expand to form a perfect seal. Then I heard plenty of deep bass.

What Sound!

With a good seal, the lows really plumb the depths. There's a sense of power and weight seldom heard in headphones. Yet the bass is wonderfully tight and free of coloration. You'll hear absolutely no boominess or bumped-up bass as you often do with other headphones.

Similarly, the rest of the audio range sounds accurate and neutral. Cymbals are every bit as crisp and airy as the real thing. In fact, I thought the upper highs were a little too strong until I heard real cymbals at a concert of acoustic jazz the day

after auditioning the ER-4S. These earphones play all the highs that are in the recording. If the sound is too bright, you can nudge down the treble on your preamp.

The transient response, clarity and detail of the ER-4S are phenomenal. Due to the low moving mass of the earphones' diaphragm, it tracks the incoming signal accurately. Quite simply, these are the most transparent, revealing 'phones I've had the pleasure to hear.

The ER-4S tonal balance reminds me of Sony MDR-V6 headphones (now called MDR-7506), but with less bass, more extended highs and a smoother response. It's as if the ER-4S started with the response of the MDR-V6, then refined it by an order of magnitude.

The Etymotic ER-4S earphones provide an entry into the high end of audio for only a few hundred dollars. If you crave reference-quality sound with comfort and noise exclusion, the ER-4S earphones will give it to you. Highly recommended.

They have a 1-year warranty and a 30-day return privilege.

FOR MORE INFORMATION CONTACT:



ETYMOTIC RESEARCH

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ETYMÖTIC RESEARCH ER-4 EARPHONES

The Etymotic Research ER-4 earphones are a perfect example of the reason that I use the term "earphones" rather than "headphones." "Earphones" is a broader term and, in this case, is a more accurate description because the ER-4s are designed to be inserted in your ears; in fact, they are different than most "in-the-ear" earphones that you see people wearing because they fit right into your ear canals.

I have known Mead Killion, one of the designers of the Etymotic ER-4 earphones, since the late 1970s, when we both belonged to the Chicago Acoustical and Audio Group. Killion worked for Industrial Research Products, a division of Knowles Electronics, for 22 years. One of his major accomplishments there, which helped to revolutionize the hearing aid business, was his proprietary design of the K-AMP amplifier. This is a true, high-fidelity, miniature amplifier used by various companies

SPECS

Transducer Design: Dynamic.
Coupling to the Ear: In-the-ear.
D.c. Resistance: Left, 100 ohms; right, 100 ohms.
Absolute Polarity: Positive.
Cord: Straight, 4 feet long, from each earphone; 1/8-inch stereo phone plug (1/8-inch to 1/4-inch adaptor included).
Adjustments: None.
Weight: Less than 1 ounce.
Price: \$330.
Company Address: 61 Martin La., Elk Grove Village, Ill. 60007.
For literature, circle No. 92



in many different hearing aids. Presently, Killion has 18 patents in the field of hearing aids and earphones. He started Etymotic Research in 1983, and his motto is *still* "Making things better for people."

Besides producing the ER-4 earphones, Etymotic also makes The Musicians Earplug, which was invented by Elmer Carlson, Killion's co-worker and mentor at Industrial Research. Etymotic makes these

superior, noise-reducing earplugs under license from Knowles Electronics.

The ER-4 earphones are available in two versions, the ER-4B and the ER-4S. The "B" version was designed for binaural listening and the "S" version for stereo listening. What is the difference, you may ask? Years ago, there was some confusion between the terms "binaural" and "stereo." Two-channel recordings were being made using both spaced microphones and dummy-head microphones, as well as combinations of both.

**ETYMÖTIC'S ER-4s ARE
DIFFERENT THAN MOST
"IN-THE-EAR" 'PHONES,
AS THEY FIT RIGHT INTO
YOUR EAR CANALS.**

PARAMETER	RATING	COMMENTS
Overall Sound	Excellent	
Bass	Excellent	"Tight bass" and "Low sounds are amazing"
Midrange	Excellent	"Bright but not harsh" and "Clear and clean"
Treble	Excellent	"Good transients"
Overall Isolation	Excellent	
Bass	Excellent	"Outside sounds felt but not heard"
Midrange	Excellent	"Excellent isolation"
Treble	Excellent	"Excellent isolation"
Comfort	Excellent	
Value	Excellent	"Good value"

GENERAL COMMENTS: Very comfortable; good fit; comfortable for long-term listening; excellent isolation from outside noises; overall fantastic sound.

As is still the case today, listeners used spaced louspeakers or earphones to listen to these two-channel recordings. Most of the recordings did not clearly indicate which recording methods were used. In fact, the famous binaural records produced by Emory Cook (a true innovator and giant in the field) in the early 1950s were made using spaced microphones!

A turning point came when an article appeared in *Audio Engineering* (the precursor to *Audio*) by Russell Tinkham that clearly differentiated between "binaural" and "stereo." Binaural was defined as listening with two ears, and stereo was defined as listening to a solid (the Greek word *stereos* means solid) sound field produced by two or more loudspeakers.

Why, then, would Etymotic Research produce two different versions of the ER-4? Most recordings are made using multiple microphones that are placed close to the instruments and then mixed to the final two-channel format. Because the mikes are so close to the instruments, they pick up high frequencies with little loss of level. By contrast, binaural recordings are made with a dummy-head microphone system that is placed away from the instruments to achieve a good perspective and sense of space. Because most of the instruments produce less high-frequency energy out toward a normal listening position, where the dummy head and mikes are located, the high-frequency level on a recording is reduced. Compared to the ER-4B, the ER-4S has a response characteristic that is sloped downward, starting at about 1 kHz, and it

ings made with spaced microphones placed away from the instruments.

I used both the ER-4S and the ER-4B, and I liked both of them. If I had to choose, I would take the "B" version. In addition to recordings made for binaural listening,

**IF YOU ARE LOOKING FOR
EARPHONES THAT REDUCE
OUTSIDE NOISE, YOU
WILL FIND NONE BETTER
THAN THE ER-4s.**

most classical recordings also sound good with the ER-4B. If you listen to rock music, which is recorded with close microphones and mixed to two-channel (I find it hard to call this type of recording stereo), you may prefer the balance provided by the ER-4S. This will be especially true if you listen to portable CD or cassette players that have no treble control that would allow you to reduce the high frequencies.

The Etymotic ER-4 earphones are very small, but despite this they have a serial number on the body. To distinguish the left and the right earphones, the right side is designated by a red strain relief at the transducer end of the cord. The plastic body of each earphone is 1 inch long and 1/4 inch in diameter. The body extends 3/8 inch into the plastic earmold that fits over it. The earmolds have three soft plastic flanges that seal to your ears. With a tight seal, the

is down about 5 above 8 kHz. This response will be better for close microphone recordings. The ER-4B is designed to produce a true diffuse-field type of response for recordings that were made with the microphones away from the instruments. Besides recordings made with a dummy head for binaural listening, you can also enjoy many of the older record-

bass is phenomenal; you will hear low-frequency sounds that you didn't even think were possible, especially from CDs. You can tell when the earphones are sealed properly: If you snap your fingers near your ear, you will hear nothing! If you are looking for earphones that reduce outside noise, you will find none better than the Etymotic ER-4s.

Although the ER-4s fit tightly in my ears, I found them to be very comfortable, even for extended listening. If you want increased comfort, you can have custom earmolds made; Etymotic will provide information about how these can be obtained in your area. Since the earphones are placed right into your ears and have no headband and a very light cord, it is easy to forget that you are wearing them.

Some members of my listening panel didn't like inserting the ER-4s into their ears and preferred earphones that surround the ear. Some of them were won over by the superior sound qualities and decided that it was worth placing the ER-4s in their ears properly. I asked each panel member to listen to various types of program material and write down their comments.

I measured the ER-4s with a B & K 4134 pressure mike mounted in a Zwislocki coupler. The response was essentially the same as that shown in Etymotic's literature and followed the desired earphone response characteristic very closely. The bass was flat to 40 Hz and was down only 3 dB at 20 Hz. The treble response was close to perfection all the way out to about 17 kHz. Comments by panel members—such as "fabulous bass," "tight bass," and "low sounds are

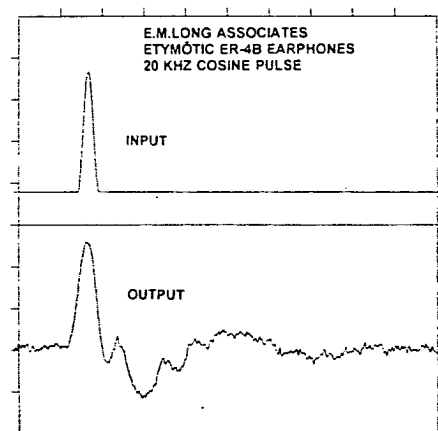


Fig. 1—Cosine-pulse test for ER-4B.

amazing"—verified that the extended low-frequency response that I measured with the coupler was heard when the earphones were sealed properly.

Comments about the sense of presence and articulation were: "Excellent on voices," "clear and clean," and "bright but not harsh." These remarks indicate that the equalization characteristic designed into the ER-4B is right on target. When I wrote "As Close As You Can Get" (April 1991), I stated that I chose the Stax SR-Lambda Pro Earspeakers as a reference for evaluating other earphones. In the "Auricle" review of the Stax Earspeakers (also April 1991), I mentioned I had received a prototype earphone from Etymotic Research that would have been my other choice for a reference, but the Stax SR-Lambda Pros were available and highly regarded by many people as being, perhaps, the best available earphones. The panel members all commented that the ER-4s were brighter than the Stax reference earphones, but without being harsh. The ER-4s opened the sound and lifted the veil compared to the Stax, especially for large-scale classical music.

Figure 1 is the output of the Etymotic ER-4 for a 20-kHz cosine input. The input pulse is shown at the top, and the output from the ER-4B earphones is below. The output, after the input has stopped, shows excellent recovery and almost no "ringing" due to delayed energy. This correlates well with a listener's comment of "very tightly controlled sound" and other comments, such as "excellent details" and "good transients." It also shows that the ER-4B produces a positive acoustical output for a positive electrical input. This resulted in comments about how easy it was to determine the correct absolute polarity when an amp's polarity switch was used while voices, brass instruments, and other asymmetrical musical sounds were being played.

The Etymotic ER-4 earphones are efficient and can produce very high sound levels with relatively little input power. The members of the listening panel gave the ER-4 earphones an overall sound quality rating of "excellent" and an "excellent" rating for physical attributes. I personally think that they are better than the Stax SR-Lambda Pro reference earphones. When the price is considered, I think that the ER-4s are an excellent value. *Edward M. Long*

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Zugegeben: Es gibt viele Hi-Fi-Geräte, die appetitlicher aussehen. Aber nur wenige, die besseren Klang erzeugen.

So bezeichneten die Ästheten unter den AUDIO-Redakteuren den 800 Mark teuren ER 4 S despektierlich als „Schmalzbohrer“ – was sich die Ohrhörer-Schöpfung von Etymotics Research auch gefallen lassen muß. Schließlich nistet sich der Stöpsel mitten im Gehörgang audiophiler Glaubensbrüder ein.

Um im empfindlichsten Organ eines Audiophilen keinen Schaden anzurichten, verpaßten die Ingenieure ihren knapp vier Millimeter dicken Röhrchen einen Weichgummi-Überzieher. Folgerichtig sollte der HiFi-Fan nicht nur seine Tonköpfe, sondern auch seine Ohren mit Wattestäbchen bearbeiten, bevor er sich in Erwartung köstlichen Musikgenusses die Ohren verstopft. Andernfalls könnte Ohrenschmalz die feinen Drahtgitter vor den Membranen verstopfen und einen Filterwechsel notwendig machen – dank des mitgelieferten Werkzeugs kein Problem.

Auch der Tragekomfort ist ungewöhnlich: Das anfangs seltsame Gefühl, das die Knöpfe im Ohr verursachen, schwindet schnell. Man hat sogar ein Gefühl von Bequemlichkeit – vorausgesetzt, man benutzt den mitgelieferten Clip, um das Kabel beispielsweise am Hemdkragen zu fixieren. Ohne ihn werden störende Rumpelgeräusche durch die Kabelbewegung übertragen.

Die ungewöhnliche Konstruktion der Etymotics-Hörer beruht auf der Idee, daß Musik normalerweise mit Mikrofonen aufgenommen wird und nicht mit Ohren: Wenn man bei der Wiedergabe ebenfalls die akustische Wirkung der Ohrmuscheln ausklammert, erhält das Ohr exakt den Schalldruck, wie ihn das Mikro registriert hat. Allerdings wird es schwierig, so die Rauminformation zu erhalten, es sei denn, schon das Mikro selbst hatte „Ohren“: Eine Kopf-Attrappe, mit Mikrofonen bestückt, liefert diese besonderen Aufnahmen. Und die werden vom ER 4 S exakt da reproduziert, wo sie aufgenommen wurden; schließ-

Foto: Roy Ego



Test: Im-Ohr-Hörer Etymotics Research ER 4 S

KNOPF IM OHR

Mit einem Ohrstöpsel wollen die Spezialisten von Etymotics Research der akustischen Wahrheit ein Stück näherkommen.

DEM MESSLABOR

Malte
Neumann

Klangunterschiede zwischen CD-Laufwerken galten bis vor kurzem als Hirngespinnste. Inzwischen sind sie kaum noch umstritten und sogar technisch erklärbar geworden.

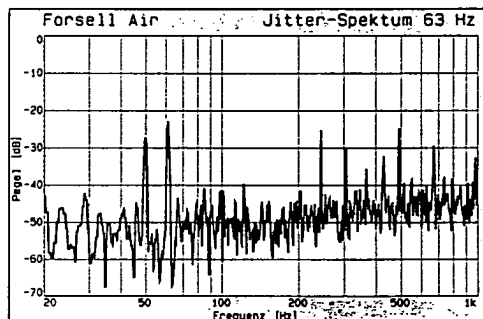
Ein CD-Laufwerk liefert kein Musiksignal, sondern einen Datenstrom, in dem die gesamte Information steckt. Der Digital-/Analogwandler macht daraus ein Audio-Signal – und nur an dieser Stelle können Klangunterschiede entstehen. Wenn aber die Daten korrekt angeliefert werden, müssen sich Verzerrungen auf anderem Weg einschleichen. Hier bietet die übliche Art der Datenübertragung einen Angriffspunkt, denn außer den reinen Daten wird in den Flanken des Digital-Signals auch der Takt an den Wandler weitergeleitet.

Erfolgt die Wandlung aufgrund von Unregelmäßigkeiten (Jitter) nicht in absolut gleichen Zeitabständen, treten im Musiksignal Störungen auf. Die Ursachen können in

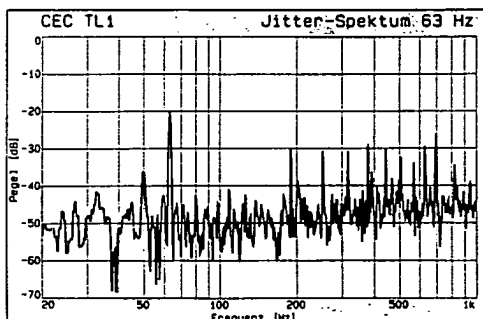
der Elektronik des Laufwerks liegen, aber auch durch Probleme bei der Übertragung entstehen. So sind die relativ langsamen optischen Toslink-Verbindungen prädestiniert, schlechtere Resultate abzuliefern. Allerdings gilt auch hier: Laufwerk, Kabel und Wandler bilden ein System und können nur gemeinsam beurteilt werden. Ein völlig resistenter Wandler könnte also die Klangunterschiede bei Laufwerken beseitigen.

Dagegen kann eine schlechte Taktrückgewinnung im Wandler den Jitter verstärken. So erklären sich auch die Schwierigkeiten, aus den Meßergebnissen für den Jitter eine Aussage über gut oder schlecht zu machen; zudem ist völlig unklar, wie das Ohr auf die Störkomponenten reagiert.

Noch tiefer im Nebel liegen die Einflüsse der Laufwerkmechanik: Wie die recht unterschiedlichen Ansätze zeigen, herrscht auch bei den Herstellern Einigkeit nur in dem Punkt, daß es sicher nichts schaden wird, die Geräte möglichst schwer und solide zu bauen – vielleicht würde es auch viel einfacher gehen, wenn man an den richtigen Stellen sparen würde, aber die kennt bisher niemand.



Das C.E.C. liefert bei der Signalfrequenz 63 Hz die stärkste Jitter-Komponente.



Beim Forsell sind die dritte und siebte Oberwelle fast so stark im Spektrum vertreten wie die Grundfrequenz.

NEU AUF MOOD RECORDS

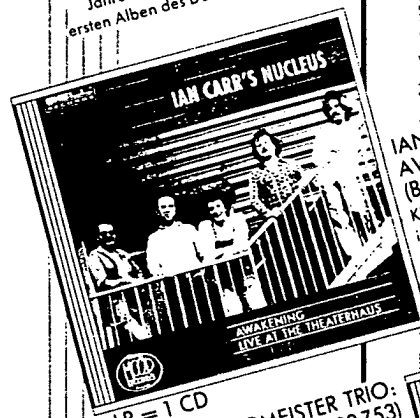
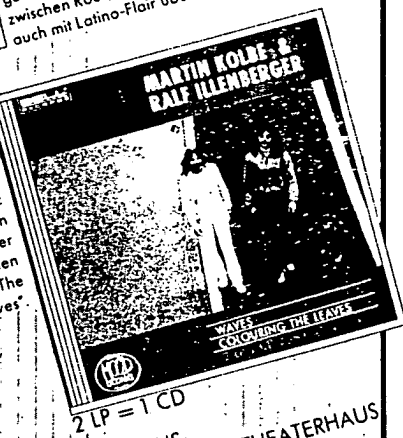
Produktion der Musiker

BELL
RECORDS



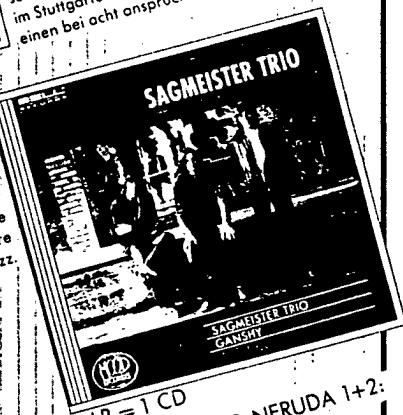
ANNE HAIGIS:
FOR HERE WHERE THE LIFE IS FINGERNAILS (BLR 83750)
Eine Stimme wie schwäbisches Urgestein: Die beiden ersten Platten von Anne Haigis – „For Here Where The Life Is“ und „Fingernails“ – finden sich in voller Länge auf dieser CD. Sie zeigen eine Sängerin, deren unverwechselbare Stimme mühelos zwischen Rock, Blues und Jazz vermittelt und dabei auch mit Latino-Flair überzeugt.

MARTIN KOLBE + RALF ILLENBERGER:
WAVES · COLOURING THE LEAVES (BLR 83751)
2 LP = 1 CD
Deutschlands Gitarrenduo Nummer eins: Martin Kolbe und Ralf Illenberger verschmelzen Folk und Rock, Jazz und Kammermusikalisches zu einer freien, virtuosen Spielweise, die stilprägend für die gesamten 80er Jahre wurde. Auf dieser CD finden sich die beiden ersten Alben des Duos – „Waves“ und „Colouring The Leaves“.



IAN CARR'S NUCLEUS:
AWAKENING · LIVE AT THE THEATERHAUS (BLR 83752)
2 LP = 1 CD
Klassischer Rockjazz: Der Trompeter Ian Carr, Mitglied im United Jazz + Rock Ensemble, als Bandleader. Kraftvolle Rhythmen und brillante Soli prägen den Rockjazz seiner britischen Band „Nucleus“. Die im Studio und live im Stuttgarter Theaterhaus aufgenommenen Titel vereinen bei acht anspruchsvollen Titeln Spielwitz und Herz.

MICHAEL SAGMEISTER TRIO:
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2 LP = 1 CD
Gitarre perfekt: Die schönsten Titel der beiden ersten Scheiben von Deutschlands bestem Jazzgitaristen vereinen melodische Eleganz, Wärme, Feingefühl für dynamische und harmonische Entwicklungen sowie exzellente, nie aufdringlich wirkende Technik. Lockere Latin-Beats, Balladen und ausgereifter Rockjazz.



POESIE UND MUSIK – PABLO NERUDA 1+2:
EIN MENSCH KAM ZUR WELT TIERSAMMLUNG (BLR 83750)
2 CD
Große Träume: René Bardets Programm mit Texten des chilenischen Dichters Pablo Neruda erzählt von Träumen, der Sehnsucht nach Glück und Geborgenheit, Hoffnungen und Nöten, Privatem und der großen Politik, von Liebe und dem Kampf gegen Hunger. Leise Zwischenklänge von Gitarre, Bouzouki, Cello, Percussionsinstrumenten, Flöten, Saxophonen und Elektrobaß erhöhen die emotionale Wirkung der Texte.

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lich sitzt die Membran des Hörsers an derselben Stelle wie das Mikrofon beim Kunstkopf.

Ein anderer Aspekt ist die totale Abschottung von der akustischen Umwelt: Selbst in einer lauten Umgebung kann man ungestört genießen, ohne den Lautstärkeregler allzu weit aufdrehen zu müssen. Ungestört bleiben auch die Sitznachbarn, denen kein Scheppern und Zischeln verrät, welches Tempo der Drumcomputer gerade anschlägt. Allerdings sind die Etymotics für al-

le Verkäufernehmer aus diesem Grund tabu.

Mit den Stöpseln können sich Musikk Liebhaber richtig in die Klangwelten zurückziehen; Kunstkopfaufnahmen vermitteln einem das Gefühl, mittendrin im Geschehen zu sitzen. Die unscheinbaren Amis bilden den gesamten Raum mit allen Hallanteilen perfekt ab – Im-Kopf-Ortung wird zum Fremdwort.

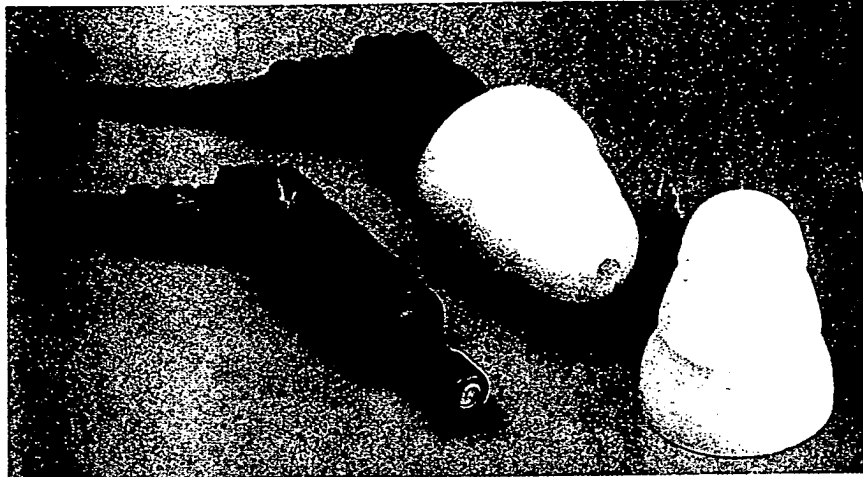
Ideale Aufnahmen für die Ohrhörer finden sich auf der AUDIO-CD *Stakkato Spezial*,

wobei aber generell gilt: Je besser die Aufnahmetechnik, um so luftiger klingt's. Erst bei Pop, mit vielen Mikros produziert, bleibt die Musik mitten im Kopf. Dennoch klingt sie sehr stimmig, weil der ER 4 S den Mitteltonbereich unerhört präzise und neutral wiedergibt. Beim vielschichtigen Percussion-Spiel von Ana Carams Begleitern (Chesky) kommen selbst die elektrostatischen Superhörer von Stax oder Koss in Bedrängnis und können sich nur durch die klar bessere Hochton-

auflösung und den satteren Baß einen Punktevorsprung retten. Faszinierend auch die knackige Wiedergabe kurzer Druckwellen, wie sie Bassdrums oder Händeklatschen erzeugen: Kein anderer Kopfhörer und kaum ein Lautsprecher macht das den Schmalzbohrem nach...

Auch nicht der Vivanco SR 1000 ifl (Test AUDIO 6/1993), der aber – trotz seiner Defizite in Präzision und Neutralität – dank seines luftigeren Höreindrucks gleichzieht, und so werden die Knöpfe künftig mit 75 Punkten in der Bestenliste geführt.

Wenn es aber darum geht, per Kunstkopf aufgezeichnete Musik zu verbreiten, ist der ER 4 S eine spitze – genauso wie er auch als bester uneingeschränkt mobiler Kopfhörer gelten muß. Winzige Abmessungen und hervorragender Klang gingen ja bisher nicht zusammen. Und wenn ein Winzling wie Sonys Scoopman (AUDIO 7/1992) zuliefert, paßt alles, was man für zehn Stunden HiFi-Genuß braucht, buchstäblich in die Hosentasche – ein mobiles Dream Team für zweieinhalbtausend Mark. □



Hörrohr: Die Weichgummi-Polster sorgen für einen bequemen Sitz der winzigen Hörerkapseln.

AUS DEM MESSLABOR

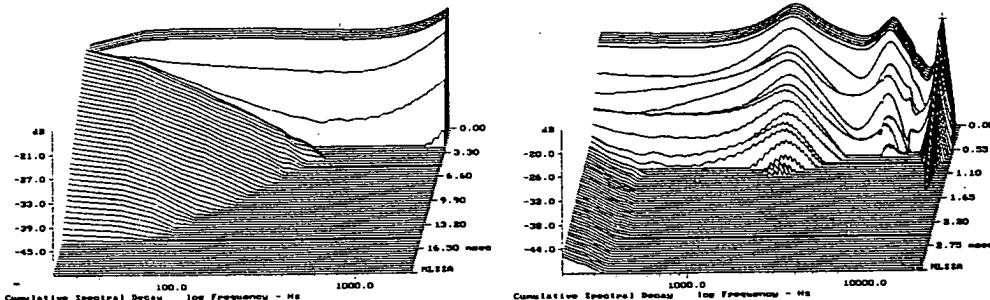
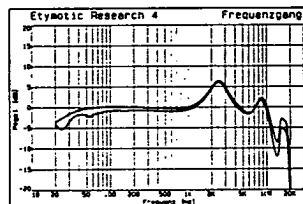
Malte Neumann

Auch wenn der Frequenzgang des Etymotics Research nur unterhalb von 1 kHz sehr ausgewogen aussieht, dürfte er dennoch recht nahe an der akustischen Wahrheit liegen: Wenn die Einflüsse der

Ohrmuscheln wegfallen, würde ein gerader Frequenzgang ein merkwürdiges Klangbild ergeben (Stichwort: Diffusfeldverzerrung). Das Auf und Ab im oberen Mitteltonbereich entspricht ziemlich genau dem von verschiedenen Forschern gemessenen Einfluß unserer Hörwerkzeuge.

Das Zerfallsspektrum gehört zu den besten, die AUDIO je gemessen hat: Im gesamten Mitteltonbereich schwingt der ER 4 S extrem schnell und ohne sichtbare Resonanzen aus. Erst bei etwa 16 Kilohertz zeigt sich

ein kleinerer „Bergrücken“, der aber kaum sonderlich zum Höreindruck beitragen dürfte. Hier machen sich die Vorteile des Im-Ohr-Prinzips bemerkbar, weil sich in den winzigen Hohlräumen vor und hinter der Membran kaum Resonanzen im Hörbereich bilden können.



Sehr sauberes Ausschwingen im gesamten Frequenzbereich beim Etymotics Research ER 4 S.

Hersteller

ETYMOTICS RESEARCH

(Pasco, 6902 Sandhausen)

Modell	ER 4 S
Preis (Herstellerangabe)	800 Mark
Garantiezeit	24 Monate
Gewicht	28 g
Übertragungstechnik	
Wandlerart	dynamisch
Akustisches Prinzip	–
Ohrankopplung	im Ohr
Impedanz	100 Ohm
Ausstattung	
Anschlußstecker	Klinke 6,3 mm – Klinke 3,5 mm ● DIN (Würfel) – mehrfach –
Kabellänge	125 cm
Kabel gesteckt	●
Ohrkissen abnehmbar	●

	Urteil	Punkte
Klang		75
Tragekomfort	gut	
Verarbeitung	sehr gut	

Platzhirsch Oberklasse

Wenn ein ostafrikanischer Elefant seinen Rüssel in Buschpfade steckt, ahnt er nicht, daß er damit die oft eintönige Kultur heimischer HiFi-Stuben aufmöbelt.

Voraussetzung dafür ist allerdings, daß der Dickhäuter mit den Riesenohren an Bäumen der Gattung Karasinga vorbeischiebt und sie zu Kleinholz trampelt: Mo Iqbal, gebürtiger Kenianer und innovativer Kopf der britischen Lautsprecher-Szene, läßt das somit natürlich geschlagene Heimat-Holz auf-sammeln und als Furnier für seinen neuen Zweiwege-Zwerg Monitor Audio Studio 6 veredeln.

Noch mehr Wert als auf die natürlich-optische Erscheinung seiner Studio 6 legt Iqbal, genau wie seine Konkurrenten beim kalifornischen Lautsprecherspezialisten JBL mit ihrer Ti 1000, auf naturbelassenen Klang. Dabei ist für beide ein Punkt ganz klar: Tonangebend müssen nicht unbedingt großmächtige Klang-Hölzer im Jumbo-Format nach dem Motto „viel Klang fürs Geld“ sein. Denn die Physik verbietet den Zwergen nur eines: den Tiefbaß. Alle anderen Kriterien meistern die Kleinen genauso gut – oder schlecht – wie die Großen.

Bei der Konstruktion seiner Studio 6 verließ Mo Iqbal die Trampelpfade des traditionellen Boxenbauer-Dschungels und beschritt zumindest mit der Auswahl der Chassis-Materialien einen unkonventionellen Weg. Wie schon im großen Bruder-Modell Studio 20 (siehe Test in AUDIO 10/1992) wandeln den gesamten Frequenzbereich Metall-Membranen – für tiefe Tonalagen verwenden die meisten Entwickler Kunststoff- oder Papp-Konusse.

Seinen 17-Zentimeter-Tief-mitteltöner mit einer Membran aus Aluminium-Magnesium-Legierung überzieht Iqbal mit einer sechs tausendstel Millimeter feinen Keramikschicht, die angeblich den Konus versteift und zusammen mit einer weichen Gummisicke für ein resonanzarmes Spiel sorgt. Die Verbindung aus Metallkonus

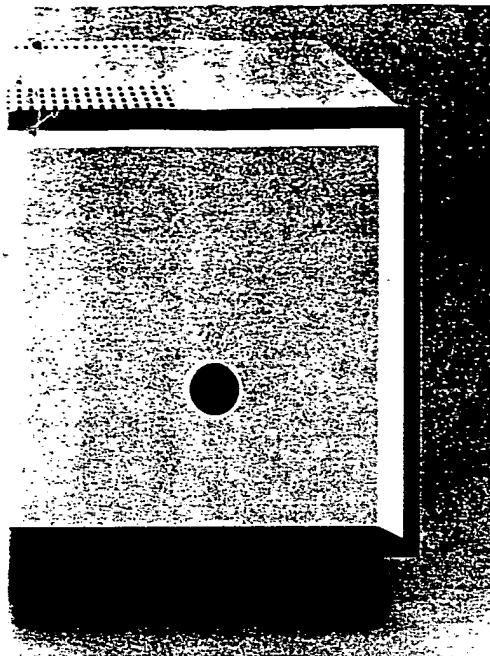
Fotos: Jörg Kubitzo, Stuttgart



Test: Zwei edle Zweiwege-Lautsprecher ab 3200 Mark

LITTLE FEAT

Diese High-End-Boxen leben auf kleinem Fuße – zeigen aber dennoch wahre Klang-Größe.

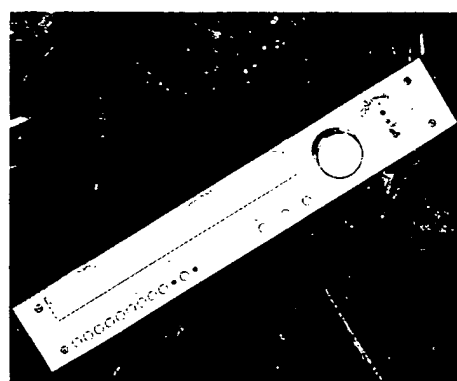


Sony TA-F519R	650	58	1'93	55 CD (60MC)	00
Yamaha AX-550 (FB)	700	59	4'91	55 CDD (55MM)	00
Rotel RA-820A	480	46	11'88	50 CD (+0MM)	000
Kenwood KA-3020	400	39	1'91	50 CDD (45MM)	00
Kenwood KA-4020	500	49	11'91	50 CDD (45MM)	00
Kenwood KA-4040R	650	57	12'92	50 CDD (50MC)	00
NAD 3100	1000	59	11'89	50 CD (+5MM)	00
Pioneer A-401	500	56	12'92	50 CDD (+0MM)	00
Sherwood AI-5010	500	57	7'91	50 CDD (+5MM)	00
Denon PMA-280	400	49	11'91	+5 CDD (+5MM)	00
Dual CV 650 RC	470	56	6'92	+5 CD (+0MM)	00
Kenwood KA-1030 (FB)	300	48	3'92	+5 CD (+5MM)	00
Sansui AU-X117	300	45	2'93	+5 CDD (+0MM)	00
Telefunken HA-880 (FB)	600	56	6'90	+5 CD (+0MM)	00
Alwa XA-008	300	55	3'92	+0 CDD (+0MM)	00
Fisher CA-9030	450	36	7'91	+0 CD (35MM)	00
Technics SU-V2220	300	48	2'93	+0 CDD (+0MM)	00
Yamaha AX-350	300	45	2'93	+0 CDD (+0MM)	00
Grundig V 303 (FB)	500	40	6'92	35 CD (35MM)	00
Telefunken HA 680	400	33	11'91	35 CD (35MM)	00

Tuner

Ab Heft 6/88 hat AUDIO den Empfangstest perfektioniert. Hinter den Gesamtpunktzahlen der nach diesem Verfahren geprüften Geräte stehen die Einzelwertungen für Klang (K) und Empfang (E).

Modell	Preis	Test	Gesamtpunkte	Prädikat
Spitzenklasse				
Burmester 915 (m. Dynas)	10400	4/92	90 (K90/E89)	00000
Onkyo T 9990	1600	1'88	87	00000
Accuphase T-108	2600	7'90	85 (K90/E80)	00000
Revov B 160	1800	11'68	84 (K85/E82)	00000
Fine Arts T-9000	1800	10'67	82	00000
Technics ST-G 90	1000	4'80	80 (K80/E80)	00000
Burmester Concerto FM Tuner	4750	1'93	78 (K90/E66)	00000
Naim NAT 01	6300	1'88	77 (K95/E59)	00000
Yamaha TX-2000	1700	6'89	76 (K75/E77)	00000
Oberklasse				
Yamaha TX-930	800	4'90	73 (K80/E66)	00000
Kenwood KT-5020	500	4'90	70 (K70/E70)	00000
Grundig T 305	500	1'93	69 (K65/E73)	00000
Kenwood KT-7020	700	4'90	68 (K70/E66)	00000
Sony ST-S 390	400	8'92	68 (K65/E70)	00000
Restek Scalar	3200	6'88	66 (K85/E46)	00000
Kenwood KT-1020L	300	2'91	55 (K65/E64)	00000
Pioneer F-550 RDS	500	8'92	65 (K65/E64)	00000



Wellenreiter: Zu Referenzehren kam der Burmester-Tuner 915 insbesondere dank der effektiven Dynas-Schaltung.

Grundig T-907	930	8/92	64 (K65/E63)	000
Technics ST-GT630	500	1'93	63 (K60/E66)	000
Fisher FM-9050	300	11'91	62 (K65/E58)	000
Philips FT930	450	1'93	62 (K60/E64)	000
Technics ST-610	300	2'91	61 (K65/E56)	000
Mittelklasse				
Dual CT 700 RS	370	6'92	60 (K65/E55)	000
Grundig T 301	300	11'91	60 (K65/E55)	000
Telefunken HT-780 RDS	400	4'90	59 (K60/E57)	000
Harman/Kardon TU 9200	500	6'92	57 (K65/E49)	000

T 229	300	11'91	57 (K65/E48)	00
Sony TU-X301i	400	4'90	56 (K55/E57)	00
Grundig T 304	400	6'92	55 (K60/E50)	00

Kopfhörer

Spitzenklasse				
Stax SR Lambda Signature	2300	2'88	90	00000
Koss ESP 950 mit E/90	3800	4'91	90	00000
Stax SR Lambda Professional	2000	2'88	90	00000
Jecklin Float Elektrostat	1000	2'88	85	00000
AKG K 1000	1575	11'90	80	00000
Stax SR-Gamma Pro mit SRD-7MKII	1000	9'86	80	00000
Oberklasse				
Elymotic Research ER 4 S	800	7'83	75	00000
Viviano SR 1000fil	300	6'93	75	00000
Beyer DT-990	240	3'87	70	00000
Beyer DT-811	350	12'91	70	00000
Sennheiser HD 560 Ovation II	300	12'91	70	00000
Audio Technica ATH-911 Sovereign	300	12'91	65	00000
MB Quart Phone 90X	200	12'91	65	00000
Vivanco SR 909	200	12'92	65	00000
Mittelklasse				
AKG K 141 Monitor	160	1'90	60	00000
MB Quart Phone 95	250	1'90	60	00000
Sennheiser HD 1000 Charleston	450	1'93	60	00000
Sennheiser HD 480 Classic II	140	12'91	60	00000
Beyer Dynamic JRS 690 (Infrarot)	500	7'89	55	00000
AKG K 100 II	130	12'92	55	00000
AKG K 200 II	180	12'92	55	00000
Audio Technica ATH-910 Pro	200	12'92	55	00000
Beyer DT 311	100	12'91	55	00000
Beyer DT 511	200	12'92	55	00000
Koss Mac 7	160	12'91	55	00000
Sennheiser HD 520 II	170	12'92	55	00000
Sony MDR-CD 750	200	12'92	55	00000
Audio Technica ATH-611	150	12'92	50	00000
Audio Technica ATH-L2HE	100	12'92	50	00000
Koss HV/1A-Plus	150	12'92	50	00000
Koss JCK/200 (Infrarot)	450	7'89	50	00000
Koss Porta Pro	150	11'90	50	00000
Panasonic RP-HT 137	150	12'92	50	00000
Sony MDR-CD 250	90	12'92	50	00000
Sony MDR-CD 450	130	12'92	50	00000
Sony MDR-CD 550	160	12'92	50	00000
Audio Technica ATH-U7P	150	12'92	45	00000
MB Quart Phone 35X	100	12'92	45	00000
Pioneer SE-400D	100	12'92	45	00000
Pioneer SE-700D	145	12'92	45	00000
Sennheiser HD 440 II	70	12'92	45	00000
Sony MDR-CD 350	100	12'92	45	00000
Beyer DT 211	60	12'92	40	00000
Panasonic RP-HT 117	100	12'92	40	00000
Sony MDR-54	70	12'92	40	00000
Standardklasse				
Audio Technica ATH-309	70	12'92	30	00000
Hama Studio Line SL-440	90	11'90	30	00000
Vivanco Stage SR-585	90	11'90	30	00000

Tragbare Kassettenspieler

Einordnung nach Klangnote mit Referenzhörer (Koss Porta Pro). Die Punkte in Klammern geben die Bewertung mit Originalhörern an.

Modell	Preis	Test	Gesamtpunkte	Prädikat
Oberklasse				
Sony WM-EX 88	450	5'93	65 (35)	000
Mittelklasse				
Aiwa HS-RX 810	450	5'93	60 (30)	000
Sony WM-EX 90	500	5'92	60 (50)	000
Toshiba KT-4177	340	5'88	60 (50)	000
Aiwa HS-JX 3000	800	5'92	55 (45)	000
Aiwa HS-P 705	250	5'92	55 (35)	000
Aiwa HS-PC 202 MII	180	5'91	55 (50)	000
Panasonic RQ-S15	250	5'92	55 (45)	000
Sanyo ES-P7	400	5'91	55 (45)	000

Sanyo JJ-P150	450	4/89	55 (40)	0 0
Sanyo JJ-P101	350	5/90	55 (40)	0 0
Sharp JC-272H	400	4/89	55 (40)	0 0
Sharp JC-K 99	400	5/90	55 (45)	0 0
Sony WM-190	250	5/92	55 (40)	0 0
Panasonic RQ-P 303	180	5/90	50 (40)	0 0
Panasonic RQ-V195	200	5/93	50 (35)	0 0
Sony WM-DD 33	250	5/92	50 (45)	0 0
Toshiba KT-4078	400	4/89	50 (35)	0 0
Toshiba KT-4568	230	4/89	50 (35)	0 0
Aiwa HS-PX 310	150	5/93	45 (30)	0 0
Aiwa TP-S 101	450	5/92	45 (35)	0 0
Panasonic RQ-V 520	280	5/92	45 (30)	0 0
Sony WM-EX 52	160	5/93	45 (30)	0 0
Sony WM-GX 35	260	5/92	45 (35)	0 0
Toshiba KT-4249	200	5/90	45 (35)	0 0
Aiwa HS-TA 310	110	5/93	40 (35)	0 0
Panasonic RQ-P 250	100	5/93	40 (30)	0 0
Philips AD 6613	200	5/92	40 (30)	0 0
Sanyo JJ-F70	200	5/91	40 (25)	0 0
Sanyo JJ-P 6	200	5/92	40 (30)	0 0
Sony WM-FX43	250	5/91	40 (-)	0 0
Grundig Beatboy 280	280	5/90	40 (30)	0
Aiwa HS-GS 310	100	5/93	35 (25)	0
Grundig Beat Boy 380	100	5/92	35 (25)	0
Standardklasse				
ITT-Nokia Flirt 9810	80	12/90	30 (20)	0
Sanyo JJ-P 60	140	5/90	30 (25)	0
Sanyo MGR 800D	250	5/91	30 (25)	0
Sony WM-DD11	130	12/90	25 (20)	0
Universum CP 1099	80	12/90	20 (5)	0
Universum CPR 1891	30	12/90	20 (5)	0

Cassetten

Grundlage dieser Empfehlung ist der Cassettentest in AUDIO 10/92. Da sich Cassetten nicht für alle Recorder gleichermaßen eignen, sagt Ihnen AUDIO an dieser Stelle, welches Band zu Ihrem Recorder-Typ paßt.

Der AUDIO-Chromdioxid-Tip (Typ II)

Für IEC-konform eingemessene Recorder empfehlen sich folgende, untereinander problemlos austauschbare Cassetten:

- Sony Esprit II, 69 Punkte, um 4,50 Mark.
- Scotch XS II, 67 Punkte, um 3,30 Mark.
- That's VX, 66 Punkte, um 4 Mark.

Für Recorder mit einstellbarem Bias empfehlen sich folgende Cassetten:

- Maxell XL II, 74 Punkte, um 4 Mark.
- Fuji JP II, 65 Punkte, um 4,30 Mark.

Für einmeßbare Recorder (Bias und Entzerrung) empfehlen sich folgende Cassetten, die bei nicht regelbaren Recordern zu einer Hochtonanhebung führen:

- TDK SA-XS, 73 Punkte, um 5 Mark.
- TDK SA-X, 69 Punkte, um 4,50 Mark.
- Maxell XL II-S, 64 Punkte, um 5 Mark.

Der AUDIO-Reineisen-Tip (Typ IV)
Für IEC-konform eingemessene Recorder empfehlen sich folgende, untereinander problemlos austauschbare Cassetten:

- That's MG-X, 72 Punkte, um 6 Mark.
- That's Suono, 71 Punkte, um 19 Mark.
- Sony Metal-XR, 71 Punkte, um 5,50 Mark.
- Maxell MX-S, 70 Punkte, um 10 Mark.

Für Recorder mit einstellbarem Bias empfiehlt sich folgende Cassette:

- Maxell MX, 71 Punkte, um 6 Mark.

Cassettensrecorder

Modell	Preis	Test	Gesamtpunkte	Prädikat
Spitzenklasse				
Nakamichi Dragon	4150	6/86	90	0 0 0 0 0
Nakamichi CR-4E	2000	1/89	85	0 0 0 0 0
Harman/Kardon TD 4800	2800	4/91	85	0 0 0 0 0
Nakamichi Cassette Deck 1	1500	2/91	85	0 0 0 0 0
Akai GX-75	1000	2/89	80	0 0 0 0 0
Akai GX-95	1300	1/89	80	0 0 0 0 0
Kenwood KX-9050S	1350	10/92	80	0 0 0 0 0
Teac V-7000	1200	2/91	80	0 0 0 0 0
Oberklasse				
NAD 6100	900	5/89	75	0 0 0 0
Akai GX-65	800	5/90	70	0 0 0 0
Fine Arts CT-905	1000	10/90	70	0 0 0 0
NAD 6340	800	8/89	70	0 0 0 0
Nakamichi Cassette Deck 2	1000	7/91	70	0 0 0 0
Pioneer CT-S 410	550	8/92	70	0 0 0 0
Technics RS-B 965	1000	7/91	70	0 0 0 0
Aiwa AD-F 910	700	2/92	65	0 0 0 0
Aiwa AD-F 810	500	5/92	65	0 0 0 0
Denon DRM-710	600	5/92	65	0 0 0 0
Fisher CR-9070	700	8/92	65	0 0 0 0
Kenwood KX-7030	650	2/92	65	0 0 0 0
Onkyo TA-2850	600	2/92	65	0 0 0 0
Philips FC 950	600	8/92	65	0 0 0 0
Teac V-3000	700	4/91	65	0 0 0 0
Uher UCT-370CR	600	5/92	65	0 0 0 0
Yamaha KX-930	1000	10/90	65	0 0 0 0
Mittelklasse				
Akai DX-57	600	8/92	60	0 0 0 0
Marantz SD-62	700	5/92	60	0 0 0 0
Rotel RD 865	880	12/89	60	0 0 0 0
Sony TC-K 690	650	8/92	60	0 0 0 0
Telefunken MC 990	800	4/91	60	0 0 0 0
Akai GX-32	600	8/88	55	0 0 0 0
Toshiba PC5847F	800	2/89	55	0 0 0 0
Yamaha KX-530	700	5/90	55	0 0 0 0
NAD 6325	500	10/89	50	0 0 0 0
Technics RS-BX404	400	2/93	50	0 0 0 0
Kenwood KX-5030	500	10/91	45	0 0 0 0
Onkyo TA-2820	400	10/91	45	0 0 0 0
Onkyo TA-2830	500	10/91	45	0 0 0 0
Uher UCT-237 C	300	10/91	45	0 0 0 0
Aiwa AD-F410	300	10/91	40	0 0 0 0
Dual CC 5850 RC	500	1/91	40	0 0 0 0
Pioneer CT-S 210	350	2/93	40	0 0 0 0
Sansui D-X211HX-R	550	1/91	40	0 0 0 0
Luxman K-111	550	11/88	35	0 0 0 0
Samsung RS-1200 D	400	12/91	35	0 0 0 0
Soundwave D-700	200	12/91	35	0 0 0 0
Telefunken HC 680	300	3/90	35	0 0 0 0
Universum C 4315	300	12/91	35	0 0 0 0

DAT-Recorder

Bei DAT-Recordern, die direkte Digitalaufnahmen gestatten, stehen hinter der Gesamtpunktzahl die Einzelwertungen für die Klangqualitäten von Aufnahmen mit analogen Signalen (A) und digitalen Signalen (D).

Modell	Preis	Test	Gesamtpunkte	Prädikat
Spitzenklasse				
Nakamichi 1000	23000	4/89	88 (A85/D90)	0 0 0 0
Sony DTC-59 ES	1400	10/92	83 (A80/D85)	0 0 0 0
Sony DTC-77 ES	3000	10/91	83 (A80/D85)	0 0 0 0
Onkyo DT-901	1200	4/93	80 (A75/D85)	0 0 0 0
Sony DTC-57 ES	1300	10/91	78 (A75/D80)	0 0 0 0
Denon DTR-2000	1800	9/90	78 (A75/D80)	0 0 0 0
Technics SV-DA10	1600	9/90	78 (A75/D80)	0 0 0 0
Oberklasse				
Kenwood DX-7030	1800	11/91	75 (A70/D80)	0 0 0 0
Sony DTC-670	1000	1/92	75 (A70/D80)	0 0 0 0
Grundig DAT-9009	2400	5/91	73 (A70/D75)	0 0 0 0
JVC XD-21010	3000	10/91	73 (A70/D75)	0 0 0 0
JVC XD-2505	1500	5/91	73 (A70/D75)	0 0 0 0
Panasonic SV-3700	3000	4/93	73 (A70/D75)	0 0 0 0
Pioneer D-500	1500	12/91	73 (A70/D75)	0 0 0 0
Teac R-10	3500	5/91	73 (A70/D75)	0 0 0 0
Universum DAT 4615	1000	2/92	73 (A65/D80)	0 0 0 0

Aiwa XD-S 260	1100	11/91	70 (A65/D75)	0 0 0 0
Teac R1	11500	9/88	70 (A70/D70)	0 0 0 0

Ab Ausgabe 6/92 erfolgte eine Abwertung um 10 Punkte. Grund: zunehmende Klangverbesserung bei sinkenden Preisen.

Digital-Portis

Bei Digital-Portis, die direkte Digitalaufnahmen gestatten, stehen hinter der Gesamtpunktzahl die Einzelwertungen für die Klangqualitäten von Aufnahmen mit analogen Signalen (A) und digitalen Signalen (D).

Modell	Preis	Test	Gesamtpunkte	Prädikat
Spitzenklasse				
JVC XD-P1 Pro	2470	4/93	80 (A75/D85)	0 0 0 0
Kenwood DX-7	1000	4/93	78 (A70/D85)	0 0 0 0
Oberklasse				
Aiwa HD-S 100	1000	1/92	75 (A70/D80)	0 0 0 0
Casio DA-7	1500	11/91	73 (A70/D75)	0 0 0 0
Hitachi DAT-88	2000	12/90	73 (A70/D75)	0 0 0 0
Sony TCD-D3	1500	5/91	73 (A70/D75)	0 0 0 0
Denon DTR-80P	1500	7/92	73 (A70/D75)	0 0 0 0
Sony TCD-D10	4500	4/88	68	0 0 0 0
Mittelklasse				
Sharp MD-D10	1000	7/93	50	0 0 0 0
Sony MZ-2P	900	1/93	50	0 0 0 0
Sony MZ-1	1200	1/93	48 (A45/D50)	0 0 0 0

DCC-Recorder

Bei DCC-Recordern, die direkte Digitalaufnahmen gestatten, stehen hinter der Gesamtpunktzahl die Einzelwertungen für die Klangqualitäten von Aufnahmen mit analogen Signalen (A) und digitalen Signalen (D).

Modell	Preis	Test	Gesamtpunkte	Prädikat
Spitzenklasse				
Marantz DD-82	1700	1/93	80 (A75/D85)	0 0 0 0
Marantz DD-92	2000	2/93	80 (A75/D85)	0 0 0 0
Oberklasse				
Grundig DCC-305	1200	2/93	75 (A70/D80)	0 0 0 0
Philips DCC 900	1400	10/92	73 (A70/D75)	0 0 0 0
Technics RS-DC 10	1700	6/93	70 (A65/D75)	0 0 0 0

Autoradios

Hinter der Gesamtpunktzahl stehen die Einzelwertungen für Klang Cassette (C), Klang Tuner (T) und Empfang (E).

Modell	Preis	Test	Gesamtpunkte	Prädikat
Referenzklasse				
Becker Mexico CC	2200	5/92	93 (C85/T90/E100)	0 0 0 0 0
Spitzenklasse				
Becker Mexico Diversity	2200	8/90	85 (C80/T85/E90)	0 0 0 0 0
Blaupunkt Bremen SQR 49	1100	2/90	85 (C85/T85/E85)	0 0 0 0 0
Blaupunkt Köln RCM 40	1250	5/91	85 (C85/T85/E85)	0 0 0 0 0
BMW/Becker Bavaria (Business)	1000	3/90	85 (C85/T85/E85)	0 0 0 0 0
Mac Audio M-X80	900	4/92	85 (C85/T85/E85)	0 0 0 0 0
Becker Europa 749	850	2/90	82 (C80/T85/E85)	0 0 0 0 0
Kenwood KRC 951R	1000	5/91	82 (C85/T80/E80)	0 0 0 0 0
Alpine 7519R	1500	3/92	78 (C85/T75/E75)	0 0 0 0 0
JVC KS-C G10	1250	4/92	77 (C80/T75/E75)	0 0 0 0 0
Oberklasse				
Mac Audio MX6	700	2/90	75 (C80/T70/E75)	0 0 0 0 0
Nakamichi TD-400/PA-200	2200	1/87	75 (C85/T70/E70)	0 0 0 0 0
Pioneer KEH-4000 RDS	750	6/90	75 (C80/T75/E70)	0 0 0 0 0
Alpine 7380M/Endstufe 3501	950	4/90	73 (C80/T70/E70)	0 0 0 0 0
Blaupunkt Paris RCR-42	550	4/93	72 (C70/T65/E60)	0 0 0 0 0
Kenwood KRC 651D	700	7/90	72 (C70/T70/E70)	0 0 0 0 0
Kenwood KRC 654	700	4/93	72 (C75/T70/E70)	0 0 0 0 0
Panasonic CQ-RD 10EN	800	5/90	72 (C70/T75/E70)	0 0 0 0 0
Panasonic CQ-RD 50	550	4/93	67 (C65/T60/E75)	0 0 0 0 0
Panasonic CQ-RD 05EN	600	2/91	65 (C65/T60/E70)	0 0 0 0 0
Denon DCR-600R	600	4/93	63 (C60/T70/E60)	0 0 0 0 0
Macrom 32.60D	800	2/91	63 (C70/T60/E60)	0 0 0 0 0
Philips DC 697	600	2/91	63 (C65/T65/E60)	0 0 0 0 0
Philips DC 701	500	4/93	63 (C55/T60/E75)	0 0 0 0 0
Alpine 7190M	500	2/91	62 (C60/T65/E60)	0 0 0 0 0
Mittelklasse				
Philips DC 656	400	7/90	60 (C60/T60/E60)	0 0 0 0 0

to hot rolled and cold formed products of a basic steel mill. The trial court found, and we agree, that the purpose of part 2 of schedule 6 was to cover completely in an organized systematic manner, the classification of base metals. Headnote 3(j) defines angles, shapes, and sections as products which do *not* conform completely to the respective specifications specifically set forth in the headnotes for blooms and billets, slabs and sheet bars, bars, wire rods, plates and sheets, strip, wire, rails, joint bars, or tie plates, and states that angles, shapes, and sections do not include any tubular products. The schedule for item 609.80 specifies angles, shapes, and sections, all of the foregoing, of iron or steel, hot rolled, forged, extruded, or drawn or cold formed or cold finished, whether or not drilled, punched, or otherwise advanced, and does not mention "basic steel mill." We find, as the evidence establishes, that the hemispherical product in this litigation is a "cold formed shape." We further conclude that the tariff meaning in this case is plainly manifest, simple and clear. It is not necessary in such a situation to resort to dictionaries, textbooks, scientific treatises, governmental publications, the Tariff Classification Study, or the provisions of the Brussels Nomenclature. *F. L. Smidth & Co. v. United States*, 409 F.2d 1369, 56 CCPA 77, C.A.D. 958 (1969). We find that the language of item 609.80 is unambiguous in its coverage of the instant merchandise. The plain words of the statute, particularly the inclusion of cold formed shapes, refute appellant's contention that "angles, shapes, and sections" are limited to articles produced in a basic steel mill. The record contains ample evidence that angles, shapes, and sections may be formed in a rolling mill, and it is also clear that "shapes" may be produced by forging, extruding, drawing, and may be cold formed or cold finished.

[3] Appellant also contends that the imported tank heads cannot be classified under item 609.80 because they are not of uniform cross-section throughout

their length and do not weigh over 0.29 pound per linear foot. The lower court weighed the conflicting testimony on this point and found that the presumption that the imported hemispherical shapes meet the TSUS weight specification was not overcome. We find that there is substantial evidence to support the lower court's finding on this issue and that its determination is not clearly contrary to the weight of the evidence. We will not disturb this finding. *United States v. F. W. Myers & Co., Inc.*, 45 CCPA 48, 52, C.A.D. 671 (1958).

The presumption of correctness attaching to the classification in the instant case has not been overcome by appellant. The evidence here does not establish the impropriety of that classification nor does it establish the applicability of the specified alternative miscellaneous classification. *United States v. National Starch Products, Inc.*, 318 F.2d 737, 50 CCPA 1, C.A.D. 809 (1962), cert. denied, 373 U.S. 923, 83 S.Ct. 1525, 10 L.Ed.2d 422 (1963).

The judgment below is affirmed.

Affirmed.

WORLEY, C. J., did not participate in the decision of this case.



59 CCPA

Application of Lee Ellis MURCH.
Patent Appeal No. 8743.

United States Court of Customs
and Patent Appeals.

Aug. 24, 1972.

Rehearing Denied Oct. 19, 1972.

Appeal from rejection by Patent Office Board of Appeals, Serial No. 522,374 of claims 1 through 8 and 10 of application for patent. The Court of Customs and Patent Appeals, Lane, J., held that, claims 1 through 8 of applica-

tion for patent for "blends of polyamides and ionic copolymer," allegedly exhibiting a greater blend toughness than blends differing only to extent that none of the acid groups in the copolymer were neutralized, were properly rejected as obvious, but that claim 10 relating to improvement in weld line toughness of molded articles was patentable over objection of obviousness.

Decision affirmed as to claims 1 through 8 and reversed as to claim 10.

1. Patents ⇐113(8)

Where Patent Office has made out a prima facie case of obviousness with respect to application for patent, decision sustaining rejection of application will be affirmed.

2. Patents ⇐18

Claims 1 through 8 of application for patent for "blends of polyamides and ionic copolymer", allegedly exhibiting a greater blend toughness than blends differing only to extent that none of the acid groups in the copolymer were neutralized, were properly rejected as obvious. 35 U.S.C.A. § 103.

3. Patents ⇐18

If that which appears, at first blush, to be obvious though new is shown by evidence not to be obvious, then evidence prevails over surmise or unsupported contention and a rejection based on obviousness must fall. 35 U.S.C.A. § 103.

4. Patents ⇐18

Claim 10 of application for patent for "blends of polyamides and ionic copolymer" relating to improvement in weld line toughness of molded articles was patentable over objection of obviousness. 35 U.S.C.A. § 103.

Edwin Tocker, Wilmington, Del., attorney of record for appellant; Gerald A. Hapka, Washington, D. C., of counsel.

S. Wm. Cochran, Washington, D. C., for the Commissioner of Patents; Raymond E. Martin, Washington, D. C., of counsel.

Before RICH, Acting Chief Judge, ALMOND, BALDWIN and LANE, Judges, and CLARK, Justice (Ret.), United States Supreme Court, sitting by designation.

LANE, Judge.

This is an appeal from the decision of the Board of Appeals affirming the 35 U.S.C. § 103 rejection of claims 1 through 8 and 10 of appellant's application for "Blends of Polyamides and Ionic Copolymer."¹ We affirm with respect to claims 1 through 8, but reverse with respect to claim 10.

Claim 1 is the broadest of the appealed claims and reads as follows:

1. A thermoplastic blend consisting essentially of an intimate mixture of from 50 to 99% by weight of a polyamide and, complementally, from 1 to 50% by weight of an ionic copolymer of units derived from an α -olefin of the formula $RCH = CH_2$ wherein R is H or alkyl having from 1 to 8 carbon atoms and from 0.2 to 25 mole % of units derived from an α , β -ethylenically unsaturated carboxylic acid, at least 10% of the acid groups of said acid being neutralized by metal ions.

The claims are drawn to a blend of (1) a polyamide, such as polyhexamethylene adipamide (claim 2), and (2) an ionic copolymer of (a) an alpha-olefin, such as ethylene (claim 5), and (b) an alpha-beta-ethylenically unsaturated carboxylic acid, such as methacrylic acid (claim 3) or maleic acid (claim 4), wherein at least 10 percent of the acid groups have been neutralized by metal ions, such as zinc (claim 6). The blend may additionally contain an antioxidant (claim 8), and claim 7 depends from claim 1 and defines the ionic copolymer as a random

copolymer. Claim 10 depends from claim 7 and reads as follows:

10. The thermoplastic blend of claim 7 wherein from 60 to 85 per cent by weight of said blend is said polyamide with the remainder being said copolymer and from 1 to 8 mole % of said copolymer is said acid.

Two properties of blends such as those herein claimed are relevant to this appeal. Blend toughness refers to the toughness, i. e., the ability to withstand deformation without fracture, of a molded article composed of the blend. When an article is formed by injecting the molten blend into the forming mold from two sources, a weld line is formed at the juncture of the several masses. Such a weld line would also form whenever there is an obstruction in the molding chamber. The weld line apparently represents the weakest point in the molded article, and weld line toughness refers to the toughness of an article formed from the blend where a weld line is present. Blend toughness is measured on an article molded from the blend without a weld line.

Appellant asserts that the claimed blends exhibit a greater blend toughness than blends which differ only to the extent that none of the acid groups on the copolymer are neutralized. However, the improvement in blend toughness is not considered to be exceptional or unexpected. What appellant does urge is that weld line toughness is dramatically increased for the blend defined in claim 10 when at least 10 percent of the acid groups are neutralized and that this improvement is completely unexpected. In support of these contentions, appellant submitted a Rule 132 affidavit, and on this appeal, the solicitor does not challenge the sufficiency of that showing.² Hence as we consider the prior art, we

do so with the understanding that neutralizing at least 10 percent of the copolymer acid groups produces no unexpected result with respect to blend toughness, but that insofar as the blend of appealed claim 10 is concerned, the weld line toughness is unexpectedly improved when the acid copolymer is partially neutralized.

The examiner and board relied upon Halliwell et al. (Halliwell)³ and Rees.⁴ Halliwell, the principal reference, discloses blends composed of a polyamide and an olefin-acid copolymer. The only difference between Halliwell's blends and appellant's resides in the neutralization of at least 10 percent of appellant's acid groups with metal ions. Rees discloses ionic olefin-acid copolymers and specifically teaches that the neutralization of at least 10 percent of the acid groups to render the copolymers ionic improves various copolymer properties, including toughness. The examiner reasoned that Rees provides ample suggestion for one of ordinary skill in the art to substitute the ionic copolymers for the nonionic copolymers in the Halliwell blend, and since the Halliwell blend so modified is appellant's claimed blend, the examiner rejected claims 1 through 8 and 10 under 35 U.S.C. § 103 as obvious from Halliwell and Rees. The board elaborated on the teachings in Rees which would suggest that the improvements in the copolymer would be carried over to a blend having as one of its components that copolymer. The examiner's rejection of the claims was sustained.

Appellant argues claims 1 through 8 separately from claim 10. With respect to the first eight claims, appellant contends that one of ordinary skill in the art would not be led to substitute the ionic copolymers disclosed by Rees for the copolymer component of the Halli-

2. The examiner allowed claim 9 which is directed to a process of improving the weld line toughness of an article by utilizing appellant's blend to form an article with a weld line therein.

3. French patent No. 1,386,563 patented December 14, 1964, and equivalent to

British patent No. 998,439, published July 14, 1965, which is used by the parties for convenience.

4. Patent No. 3,264,272 issued August 2, 1966, on an application filed April 8, 1963.

well blends. Appellant introduced a patent to Mesrobian et al. (Mesrobian)⁵ which discloses blends of a polyamide and a polyolefin such as polyethylene or polypropylene. Appellant claims that the Mesrobian blends lacked toughness and that Halliwell discovered that the substitution of an olefin-acid copolymer for the polyolefin of Mesrobian improves that property. Halliwell theorizes that the acid groups on the copolymer may react with the polyamide, and appellant presumes that this interaction is responsible for the improved toughness of the Halliwell blends as compared to the Mesrobian blends which lack the acid groups. Appellant's conclusion is that one of ordinary skill in the art would not neutralize any of the acid groups and thereby take away the constituents which when added improved the toughness of the composition. In short, appellant perceives a trend in blend developments toward increasing the number of acid groups in the blend. Appellant's neutralization step is contrary to the supposed trend and is urged to be unexpected, the Rees disclosure notwithstanding. As to claim 10, appellant contends that the uncontested showing of unexpected, superior weld line toughness is sufficient for patentability even if the blends are prima facie obvious from Halliwell and Rees.

OPINION

Claims 1 through 8

[1] We agree with the solicitor that appellant's suppositions regarding the reaction between the acid groups on the copolymer and the polyamide and the role of that reaction in improving toughness are unsupported and speculative. We also agree that Halliwell and Mesrobian fail to establish any trend in the area of polymer blends. Appellant's case for a trend is built entirely about the Halliwell modification of the Mesrobian blend, and we think the solicitor is justified in questioning whether one of ordinary skill in the art would make

the assumptions appellant makes only on the basis of Halliwell's discovery. In contrast to appellant's theory is the Rees disclosure which clearly points to the advantageous impact of partial copolymer neutralization on product properties. We do not think that one of ordinary skill in this art would be dissuaded from adopting the Rees improvement in polyamide-olefin-acid copolymer blends in the fear that some neutralization of the acid groups would necessarily result in a sacrifice of the improvements made by Halliwell. Rather, we are convinced that the reference teachings appear to be sufficient for the ordinary artisan having Halliwell and Rees before him to make the modification of Halliwell proposed by the examiner and board. The Patent Office has thereby made out a prima facie case of obviousness, *In re Lintner*, 458 F.2d 1013, 1016, 59 CCPA —, — (1972), and in the absence of rebuttal evidence as to these claims, the decision of the board sustaining their rejection is affirmed.

Claim 10

[2, 3] We regard the subject matter of claim 10 to be prima facie obvious from Halliwell and Rees for the same reasons as claims 1 to 8. However, the uncontested fact is that the blend of claim 10 exhibits unexpectedly improved weld line toughness as compared to the Halliwell blends. We have previously held proof of such a fact to be persuasive rebuttal of the prima facie case. See *In re Ackermann*, 444 F.2d 1172, 58 CCPA 1405 (1971); *In re Orfeo*, 440 F.2d 439, 58 CCPA 1123 (1971). As Judge Rich, writing for a majority of the court in *In re Papesch*, 315 F.2d 381, 386-387, 50 CCPA 1084, 1092 (1963), said:

If that which appears, at first blush, to be obvious though new is shown by evidence *not* to be obvious, then the evidence prevails over surmise or unsupported contention and a rejection based on obviousness must fall.

See also *In re Palmer*, 451 F.2d 1100, 1102-1103, 59 CCPA —, — (1971), wherein we said:

Appellant has cited a number of cases in his brief and at oral hearing which generally indicate that this court, as well as other federal courts, has found patentable subject matter even where the invention is apparently simple in nature or quite "close," on the surface, to the prior art, but where the small difference has eluded those of ordinary skill in the art in search of the solution to a persistent problem or where that difference unexpectedly yields an improved product or known product in an unexpectedly advantageous manner. There are many opinions of that type [footnote omitted], the point being that the legal conclusion of obviousness cannot be reached without an appreciation of the level of ordinary skill in the art, [citation omitted], and that "level" must be determined by a consideration of all evidence made available to the trier of the issue which is related to the state of the particular technology at a given point in time. When *all* the evidence is evaluated, it may well turn out, and often does, that the level of skill was not quite what it appeared to be when only a portion of the evidence, e. g., printed patents or publications, was considered.

The solicitor is of the view that in the present case where it would be "obvious" to modify Halliwell and achieve improved blend toughness, that conclusion is not weakened even when the unexpected improvement in weld line toughness is considered. He apparently urges that once the prior art has provided one of ordinary skill in the art with the motivation to make the modification not only by the suggestion to substitute the Rees copolymers for those used by Halliwell but additionally by the expectation that a significant blend property will be enhanced, obviousness must be conclusively found regardless of

the unanticipated improvement in other properties.

For support, the solicitor relies upon *In re Mod*, 408 F.2d 1055, 56 CCPA 1041 (1969), and *In re De Montmollin*, 344 F.2d 976, 52 CCPA 1287 (1965), wherein this court held certain claimed compounds to be obvious from structurally similar compounds disclosed in the prior art. In each of *Mod* and *De Montmollin*, the appellants asserted that they had discovered that the claimed compounds had a significant property not disclosed in the prior art, although the prior art compounds were thought to have a significant property which the claimed compounds possessed as well. Thus, in *Mod*, both the prior art compounds and the claimed compounds were useful as insecticides, but the claimed compounds were found to have antimicrobial activity whereas the prior art disclosures were silent in this respect. In *De Montmollin*, the claimed compounds were useful as dyes for both wool and cellulose, but while the prior art disclosed structurally related compounds useful as wool dyes, there was no suggestion of any capacity to dye cellulose products. Concluding that the claims were not patentable, Chief Judge Worley, writing for the majority in *De Montmollin*, stated:

We do not agree with appellant that a *single* variance in the properties of new chemical compounds will necessarily tip the balance in favor of patentability where otherwise closely related chemical compounds are involved.⁶

That view was reaffirmed in *Mod*.

The solicitor contends that claim 10 on appeal here is in the same posture as the *Mod* and *De Montmollin* claims. The blend defined therein shares the common significant property of good blend toughness but additionally possesses unexpectedly superior weld line toughness. There is one very crucial distinction, however, between *Mod* and *De Montmollin* on the one hand and the

6. 344 F.2d at 978, 52 CCPA at 1289.

present case on the other. The fact here is that the prior art is not merely silent on the matter of weld line toughness, but appellant has proved that the closest blends disclosed in the prior art possess *inferior* weld line toughness. In this sense, the present case is closer to *In re Ackermann*, supra, wherein the claims were drawn to a compound which in its pure state was a superior optical brightener for polyester fibers. The prior art disclosed homologues of the claimed compound and provided the suggestion for modifying the homologues to form the compound which was claimed. However, appellants proved that not only was the pure form of the compound a superior brightener as compared to the impure form, but also that the claimed pure compound was a much better brightener than the prior art homologues even in their pure state. Finding the improvement to be unexpected, the court concluded that the subject matter as a whole would not have been obvious. Balancing the prima facie case of obviousness made out by the Patent Office in the present case against appellant's objective evidence of nonobviousness, *In re Fenton*, 451 F.2d 640, 643, 59 CCPA —, — (1971), we conclude that the same may be said of the subject matter of appealed claim 10.

In *Papesch*, supra, the court held a compound and its properties to be inseparable and that proof of new or improved properties is probative of the nonobviousness of the compound. See also *In re Ruschig*, 343 F.2d 965, 52 CCPA 1238 (1965). We are aware of *Carter-Wallace, Inc. v. Davis-Edwards Pharmacal Corp.*, 341 F.Supp. 1303 (E.D.N.Y.1972), in which Judge Dooling expressed the view that a compound is effectively placed in the public domain when there is ample motivation to make it regardless of the properties it may

possess. Under his approach, newly appreciated or enhanced properties may give rise to valid patent property in the methods of using the compound which flow from the discovered properties but could have no impact on the patentability of the compound per se. With due respect to his conclusions reached after careful and exhaustive analysis of many cases involving this issue, we reaffirm the position taken in *Papesch*. To give meaning to the language of 35 U.S.C. § 103 which speaks to the subject matter "as a whole," we feel weight must be given the properties of a compound or composition of matter. See *Eli Lilly & Co. v. Generix Drug Sales, Inc.*, 460 F.2d 1096, 1103 (5th Cir. 1972).

[4] In the present case, one of ordinary skill in the art would have expected to modify Halliwell according to the tenor of the Rees suggestion and achieve a blend which would show some improvement in blend toughness. Instead, appellant has discovered that that expectation or assumption does not represent the whole truth. For some unanticipated reason, the blend so produced, not the mixture on paper defined in structural chemical terms, has an exceptional resistance to weld line fracture. This is not, in our opinion, the same composition suggested by Halliwell and Rees. We are satisfied that appellant has provided evidence which undermines the assumptions upon which the case for prima facie obviousness rests. Accordingly, the tentative conclusion of obviousness based on Halliwell and Rees must give way to a conclusion of nonobviousness. The rejection of claim 10 is reversed.

The board's decision is affirmed with respect to claims 1 through 8 and reversed with respect to claim 10.

Modified.